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Specification

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~~Method for manufacturing metallic fine structures, and application of the method in the manufacturing of sensor arrangements for the acquisition of fingerprints~~

BACKGROUND OF THE INVENTION

In the manufacturing of circuit boards, a fundamental distinction is made between the widely used subtractive technique ~~[or: technology]~~, which is based on metal-covered substrates or, respectively, base materials and which removes the metal not required for strip or printed ~~[or: printed]~~ conductors by etching, and the additive technique, which, building on substrates coated with bonding agent, applies the conductor material from baths only where strip conductors are required. Combinations of these techniques are also standard. Thus, in through-contacting, i.e., the coating with copper of the walls of perforations of conductive patterns – manufactured subtractively – that are present at both sides, the additive technique is used. In the semi-additive technique, the strip conductors are built up on thin metallic base layers, deposited for example without current, using galvanic ~~[or: electrical, metallic]~~ reinforcement, and the rest of the base layer is removed by etching, i.e., subtractively.

The techniques described above can also be applied in the manufacture of flexible wirings, i.e., what are known as flexible or membrane ~~[or: film]~~ circuits. However, in the products currently available on the market the structural dimensions of flexible wirings is greater than 100 μm. The manufacturing of significantly finer structures is currently not possible, due to the structuring methods taken over from circuit board technology and due to the adjustment precision, which is insufficient for a multilayer construction. This insufficient adjustment precision is thereby due to an unavoidable slack in the flexible organic bearer material of the flexible wirings.

Given demands for structural details smaller than 100 μm, circuits are constructed on silicon using thin-film technology. These circuits can then be made flexible, within certain limits, by means of cost-intensive grinding of the silicon bearer. Comparable wiring densities could be realized on a flexible organic bearer material only by means of a corresponding number of additional wiring layers ~~[or: planes]~~.

Summary of the Invention

The invention~~ indicated in claim 1~~ is based on the problem of creating a simple and economical method for manufacturing flexible metallic fine structures having structural details smaller than 100 µm. The method is thereby intended in particular also to be suitable for the manufacturing of the sensor field of sensor arrangements for the acquisition of fingerprints.

The invention is based on the finding that the disadvantages connected with the processing of flexible bearer materials can be avoided if a thin base layer made of a flexible organic material can first be applied onto a rigid auxiliary bearer and then detached again from the auxiliary bearer after the manufacturing of the metallic fine structures, without the risk of damages. Such a protective detaching of the base layer from the auxiliary bearer can be carried out from the back side of the auxiliary bearer using laser ablation, as long as the auxiliary bearer is made of a material that is at least largely transparent to the laser radiation used.

The inventive solution offers the following advantages:

– The use of thin-film technology on a rigid auxiliary bearer also enables the formation of multilayer fine structures.

– The high degree of resolution that can be achieved reduces the number of layers required in circuit board technology.

– The processing of rigid substrates is significantly more economically advantageous ~~advantageous [sic: economical, simple]~~ than the processing of flexible materials.

– A detaching of the one-layer or multilayer structure from the auxiliary bearer can be carried out in a rapid and economical manner.

– The assembly of ICs, passive components and sensors can for example take place, still on the auxiliary bearer, by means of gluing or soldering.

– The auxiliary bearer can be used multiple times.

– The degree of flexibility can be adjusted via the material and thickness of the lowest base layer.

– The isolation of the circuits is possible in an economical manner.

– A multilayer additional wiring can take place up to the system level.

– High mechanical loading capacity of the flexible circuits.

– It is possible to transfer the flexible circuit onto an arbitrary bearer that is also shaped three-dimensionally.

– Given the use of temperature-stable materials (cyclization temperatures 350°C), the flexible circuits can also be used at an increased ambient temperature.

– Given the use of particular materials, e.g. polyimide, the flexible fine structures are very stable chemically.

~~Preferred~~ constructions of the inventive method are indicated in claims~~s 2 to 12~~.

~~A preferred application of the inventive method is indicated in claim 13.~~

The construction of the auxiliary bearer of quartz glass ~~according to claim 2~~ enables a transparency of the auxiliary bearer to laser radiation of approximately 90 percent.

The construction of the auxiliary bearer or borosilicate glass ~~according to claim 3~~ likewise enables a transparency of the auxiliary bearer to laser radiation of approximately 90 percent, whereby, however, here the relatively low costs for an auxiliary bearer made of borosilicate glass are also to be emphasized.

The ~~Through the~~ application of an adhesive layer on the auxiliary bearer, ~~the development according to claim 4~~ enables an improved adhesion of the base layer during the processing of the construction. An ~~According to claim 5,~~ an adhesive layer made of titanium, which is transparent to the laser radiation during the detaching of the base layer, is thereby preferred. The ~~According to claim 6,~~ the adhesive layer can advantageously be applied onto the auxiliary bearer with an extremely small layer thickness by means of sputtering.

The construction of the base layer or thin film ~~according to claim 7~~ enables an extremely simple and economical application of the base layer onto the auxiliary bearer. A ~~According to claim 8~~, a film made of a thermostable polyimide is thereby preferred, especially because by this means it is made possible for the finished product to be used also at an increased ambient temperature.

With an application of a planarization, the film or base layer can then receive a ~~According to claim 9, through the application of a planarization the film can then receive a~~ very high surface quality, which enables the formation of the finest metallic structures.

Application of an insulating layer on the metallic fine structure. ~~The development according to claim 10~~ enables the application of a second layer of metallic fine structures, thus, for example, the production of a second wiring layer, whereby the flexibility of the overall construction is retained after the detaching from the auxiliary bearer. Through-contactings between the two wiring layers can thereby be realized in a simple ~~manner according to claim 11~~ through the production of holes in the insulating layer.

By means of the application of a passivation layer on the base layer prior to removing the auxiliary bearer. ~~layer, the construction according to claim 12~~ enables an effective handling protection of the overall multilayer construction.

The ~~According to claim 13,~~ the inventive method can in particular be used for the manufacture of economical sensor arrangements for the acquisition of fingerprints.

In the following, exemplary embodiments of the invention are explained in more detail on the basis of the drawing.

Brief Description of the Drawings

Figure 1 shows a partial top view of the sensor field of a sensor arrangement for acquiring fingerprints,

Figure 2 shows a section according to line II – II of Figure 1,

Figure 3 shows an arrangement for detaching the multilayer construction according to Figure 2 from the auxiliary bearer, and

Figure 4 shows a possible application of inventively manufactured flexible fine structures for three-dimensional packaging.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a partial top view of the sensor field of a sensor arrangement for the acquisition of fingerprints, whereby the multilayer construction of the sensor field can be seen in the section shown in Figure 2. In order to enable a better overview, the individual layers of the multilayer construction in Figure 2 are shown in an exploded view.

The sensor field, shown in greatly simplified fashion in Figures 1 and 2, is a multilayer construction for the manufacture of a sensor arrangement that operates capacitively for the acquisition of fingerprints. An at least partially comparable multilayer construction of a sensor field follows for example from EP-B-0 459 808.

The manufacture of the sensor field shown in Figures 1 and 2 is based on a rigid auxiliary bearer 1 made of borosilicate glass. In order to ensure with certainty the adhesion of the subsequent construction on the auxiliary bearer 1, an adhesive layer 2 made of titanium is applied by sputtering. A base layer 3 is then applied on this adhesive layer 2. In the exemplary embodiment shown, this base layer 3 is a film made of a thermostable polyimide that has a thickness of 50 μm and is applied by lamination. Subsequently, the base layer 3 is planarized by spin-on deposition of an insulating material, this process being depicted in Figure 2 by a separately shown planarization 4.

The subsequent production of metallic fine structures 5 can in principle be carried out in subtractive technique, additive technique, or semi-additive technique. In the depicted exemplary embodiment, the fine structures 5 are manufactured in semi-additive fashion as strip conductor structures. A photoresist (not shown in the drawing) is thereby applied to the planarization 4, which has been sputtered over its entire surface with a layer sequence of titanium and palladium, and this photoresist is structured in such a way that, for example, gold can be deposited galvanically, or copper can be deposited chemically or, respectively, galvanically, on the freely developed strip conductor pattern. After the stripping of the photoresist, the regions of the layer sequence of titanium and palladium not corresponding to the desired fine structures 5 are then be removed down to the surface of the planarization 4 by selective etching.

A photostructurable insulating layer 6, in which holes 61, having for example a diameter of 25 μm, can be made by exposure and developing, is then applied onto the fine structures 5. In the subsequent manufacturing of the second layer of metallic fine structures 7, which corresponds to the manufacture of the first layer of fine structures 5, through-contactings 71

are then produced that form electrically conductive connections between the two structural layers and that complete the structuring for the sensor field and the chip contacting.

The thickness of the fine structures 5 and 7 can for example be between 1 μm and 5 μm. The width of the individual structures and the spacing between the structures can unproblematically be realized with measures of significantly less than 50 μm.

Dependent on the circuit-related requirements, or, respectively, on the desire for an effective handling protection, the sensor field can finally be provided with a passivation layer 8, made for example of $BaTiO_3$, Al_2O_3, or SiO_3.

The contacting of the highly poled control ICs (not shown in the drawing) of the sensor arrangement takes place by means of gluing or soldering. For a solder connection, SnPb bumps are thereby produced galvanically using thin-film technology, said bumps being used, after the refining during melting **[or: remelting]**, as solder depots as solder deposits for the chip contacting in flip-chip technology.

After electrical and optical testing, the multilayer construction, made up of a plurality of connected individual arrangements, is for example separated or divided ~~**[or: divided]**~~ into individual sensor fields, down to the adhesive layer 2, using an Nd:YAG laser. The ablation of the layer construction from the auxiliary bearer now takes place with the aid of an excimer laser, operated with XeF (wavelength 350 nm).

The laser ablation mentioned above is carried out with the aid of an arrangement shown schematically in Figure 3. The laser radiation LS of the excimer laser is thereby directed onto a deflecting mirror 10, in the direction of the arrow 9, and, via telecentric imaging lenses 11 and 12, is deflected onto the surface of the auxiliary bearer 1. The auxiliary bearer 1, and the construction A consisting of the layers 3 to 8 (cf. Figure 2), are arranged on an X-Y table (not shown in Figure 3), which enables a scanning with a relative motion between the laser radiation LS, comprising a rectangular beam profile, and the auxiliary bearer 1. This scanning motion is indicated in Figure 3 by arrows 13.

Through the action of the laser radiation LS, in a cold process the adhesive effect between the adhesive layer 2 and the base layer 3 is increased at least to a great extent, so that the construction A can be detached, as is indicated in Figure 3 by the arrow 14. If the base layer 3 is applied onto the adhesive layer 2 with the aid of a glue, the laser radiation LS increases the effect of this glue in a comparable manner.

After a cleaning, the auxiliary bearer 1 with the adhesive layer 2 (cf. Figure 2) can be used again.

Figure 4 shows, in a greatly simplified schematic representation, how flexible fine structures 15 manufactured according to the inventive method can be used for three-dimensional packaging. After active and passive components 16 and/or sensors have been glued or soldered onto the last wiring layer, after the laser ablation described above they can be stacked one over the other by simple folding. The 3D package manufactured in this way can easily be BGA-contacted.

The inventive method can also be used for the manufacture of multilayer coils. Some single-layer or multilayer flexible coils, located next to one another, are thereby first manufactured in spiral form. These can now be placed one over the other by folding. In this way, it is possible to manufacture coils having high inductance in an economical manner.